that comes with the Weather Bureau service. Every Weather Bureau station is important, not only to the public, because of what we can do for it, but also to the observer in charge, because of what it can do for him. The stations offer innumerable opportunities to the observers to show their ability in perceiving and utilizing opportunities of usefulness to the community. The quicker a man is to see these chances, so much the surer is he to rise in the esteem of the people and of the Chief. We understand that Mr. Ridgway, from the date of taking charge at Pittsburg, devoted himself to mastering the situation as it then existed. The community came to have such confidence in his work, and such confidence in him as a man, that the new municipal administration has called him to an important public office at a large salary. Of course such public offices are not usually held by one person for many consecutive years, and we presume that Mr. Ridgway will eventually return to the Weather Bureau. Meantime we doubt not that his furlough will give him an opportunity to do a very important public work for the city of Pittsburg, and that the Weather Bureau will be proud of his career.—*C. A.*

DROUGHT AND ATMOSPHERIC ELECTRICITY.

The Chief of Bureau has received an interesting letter from Mr. W. de Ruyter van Steveninck, dated Curaçao, March 31, 1906, which may be summarized as follows:

> The island of Curaçao is at latitude 12° north, longitude 69° west, and is occupied by over 50,000 inhabitants. It is 58 kilometers long, 11 to 3 kilometers broad, and is very hilly, the highest hills rising 1200 feet. It is generally said that the rainfall was much greater fifty years ago, which I ascribe to the fact that the trees then existing conducted the negative electricity of the earth to the positive electricity of the air, thereby causing fog or rain; but these trees have now perished, and rain is scarce. It is well known that the air is always positive and the earth always negative; that where there is lightning there is also rain, and that where there is rain there is also lightning; where the lightning is strong the rain is often luminous (voluminous?). There must exist a formula showing the relation between the vapor in the air and the atmospheric electricity.

Rain does not fall in tropical trade-wind regions unless the warm surface air is suddenly raised, either by impinging on a mountain slope, or by being pushed up over an advancing stream of cooler air near the ground, or by rapidly rising in very warm localities. But these ordinary natural methods of making rain sometimes fail to bring rain for months or years together. Such failures are not to be attributed to the cutting off of woodland, or to any recent changes in the surface of the ground. General droughts and rains result alike from very extensive changes in the so-called general circulation of the atmosphere, or changes in the general position of the great centers of high and low pressure. According as these oscillate several hundred miles either way, a locality such as Curaçao may be left one year in a region of rain, and another year in a region of drought. These changes are progressive and slow; the oscillations occupy at times ten, fifteen, or twenty years; when we understand these we shall be able to predict seasons of large or small rainfall, but that time is still far distant. We do not see how any known relation between rainfall and atmospheric electricity can be of much help even in suggesting rational methods of experimentation, but the importance of the subject is so great that we gladly commend the problem to the attention of physicists.

As to our knowledge of the connection between rain and electricity we must refer to the best general summary of our knowledge of atmospheric electricity given by Mr. George C. Simpson, in the Quarterly Journal of the Royal Meteorological Society, London, October, 1905. According to this summary the electrified condition of the atmosphere consists in the presence of ions, i. e., corpuscles, atoms, or possibly molecules, of some gas or vapor in the atmosphere, each of which carries an elemental charge of electricity. A neutral atom or molecule may be broken up into two smaller corpuscles or molecules, one of them charged positively, and the other negatively. If these smaller portions reunite they will again perfectly neutralize each other. If, however, most of the positive molecules collect in one region, and the negative in another, then those two regions are said to be respectively positively and negatively electrified, that is to say there is a preponderance of the positive and negative in the respective regions. Thus, observations show that there are more positive than negative ions in the air near the surface of the ground, or near the surfaces of objects resting on the ground. The ground itself usually has a negative charge, and this would seem to suggest a plausible explanation of the reason why there is a positive charge in the air near by. A body charged with negative electricity and located in the lower atmosphere loses this charge more rapidly than it would lose a corresponding charge of positive electricity. This rapid dissipation is apparently explained by the fact that there is an excess of positive ions in the lower atmosphere, and that these, coming in contact with the body, carry off or neutralize its negative electricity. The excess of positive ions in the lower air is probably explained by the fact that the negative earth attracts the positive ions toward it.

The fundamental problem in atmospheric electricity is to determine what forces are at work in the air to produce, or introduce, these positive and negative ions. The electrified condition of the air, and the dissipation of electricity from a charged body would not be possible without the presence of ions, and no ions can be produced without the action of some ionizer powerful enough to do the great work that is going on. Mr. Simpson enumerates five possible atmospheric ionizers.

1. *Ultraviolet light.*—The ionization produced by ultraviolet rays from the sun appears to be confined entirely to the highest strata of the atmosphere, and can only produce an appreciable effect in the lower atmosphere when that upper air descends to levels that are accessible to us, by which time, however, its electric condition may have been greatly modified.

2. *High temperature.*—When a gas is heated to a very high temperature a sudden ionization takes place. It is possible that in this way volcanic eruptions contribute a small fraction of one per cent to atmospheric electricity.

3. *Chemical processes.*—This is a possible method; thus the production of ozone in the air, especially at the high temperature of the lightning flash, may contribute something, but the relation between ozone and ionization is at present hypothetical.

4. *The Roentgen or X rays.*—These rays seem to be everywhere present to a feeble extent, traversing the atmosphere in all directions. Their ultimate origin is as yet unknown, but they have the power of producing an appreciable percentage of ionization.

5. *The Becquerel, or alpha, beta, and gamma rays, given off by radio-active bodies.*—The gamma rays are essentially the same as the X rays of the fourth item. The alpha and beta rays are very efficient ionizers.

(a) It is supposed that alpha and beta rays emanate from the sun, because by this hypothesis we may explain several geo-physical phenomena, such as the earth's magnetism, the aurora borealis, and the variations of these latter with sun spots and solar prominences. These rays from the sun must, however, be absorbed by the upper atmosphere, and do not satisfactorily explain the ionization observed in the lower atmosphere.

(b) There are innumerable substances, perhaps we may say practically all mineral substances found in the earth's crust, that are radio-active, and the total effect of radiations from these is to produce a very slight ionization in the lower regions of the atmosphere.

(c) There is a radio-active emanation distributed throughout the lower atmosphere. It would seem that radio-active minerals give off a substance (gaseous or ultra gaseous) known as a "radio-active emanation," which has the power of ionizing gases, but which itself also undergoes a slow change, so that it finally disappears, or at least can not be recognized by any known method. This emanation is, therefore, one source of the ionization of our atmosphere.

Now a careful study of these last three sources of active ionizers, shows that they have not directly any large amount of influence on the dissipation of electricity from a charged body. On the other hand it may, however, be a plausible hypothesis that these electrified ions lose their properties as such by uniting into neutral molecules, or by attaching themselves to the walls, rocks, and trees of the open air, or to the particles of dust, fog, smoke, or vapor that float in the air. In fact the ions seem to form nuclei, on which water vapor accumulates when no other dust particles are present and especially when such dust-free air becomes super-saturated with moisture. An increase in the relative humidity of the air favors the recombination of the ions, or at least their neutralization, so also does an increase in the strength of the wind, and the presence of minute ice crystals at low temperatures. A dissipation of atmospheric electricity is continually going on, and this must have an effect on the negative charge of the earth's surface. There is a close connection between the rate of dissipation and the potential gradient near the earth's surface. The relation is as though the earth were continually receiving a definite quantity of negative electricity, thereby increasing the potential gradient, while the dissipation tends to diminish it. The fundamental problem is to ascertain whence the earth gets its negative charge. The hypotheses or theories attempting to explain this have been numerous, but the three best of them, namely Elster and Geitel, 1900, Ebert, 1904, and C. T. R. Wilson, 1900, have thus far failed to explain the phenomenon satisfactorily.

The preceding remarks refer to the normal conditions as to atmospheric electricity, but the abnormal conditions, which give rise to the aurora, lightning, and St. Elmo's fire, are matters concerning which we are still almost entirely in the dark. We have not yet been able to observe any connection between the aurora and the electricity of the lower atmosphere. There can be no doubt but that the electrical tension that gives rise to the lightning flash is not a simple abnormal increase in the earth's normal electrical field. The most popular theory is that of C. T. R. Wilson, namely that since aqueous vapor is deposited or condensed on negative ions with greater ease than on positive ions, therefore these fall quickly to the ground, thus giving the earth a negative charge. St. Elmo's fire is simply a brush discharge in consequence of a large potential gradient, which is, however, not large enough to cause a lightning flash. Ball lightning, and *ignis fatuus* are electrical phenomena concerning whose origin or cause we know nothing.—*C. A.*

SEVERE HAILSTORM AT PENSACOLA, FLA.[1]

By W. F. REED, jr., Observer. Dated Pensacola, Fla., March 28, 1906.

A third thunderstorm on March 2 began about 11:30 p. m., coming from the west; at 12:15 a. m. of the 3d there were incessant flashes of lightning and moderate thunder in the west; the thunder became louder and the lightning more blinding up to 1:45 a. m., when the thunder shook the houses; this storm was also attended by excessive rain, heavy hail, and high winds. Excessive rain from 12:40 a. m. to 1:30 a. m. amounted to 1.30 inches, of which 0.35 of an inch fell in the first five minutes. The wind reached 34 miles per hour for the five-minute period ending at 12:44 a. m., with an extreme velocity of 50 miles from the west for the minute ending at 12:43 a. m. A heavy hailstorm began at 12.42 a. m. and ended at 12:47 a. m.; the stones ranged from two-tenths to seven-tenths of an inch in diameter; most of them were the size of hazel nuts, and were somewhat flattened, with a center of hardened snow surrounded by transparent ice; the largest ones were of irregular shape, consisting of alternate layers of opaque snow and coatings of ice. About one-fourth of an inch of hail fell one mile northwest of the station; the fall was considerably heavier at the station, as evidenced by the markings of the hailstones on the western sides of the instrument shelter, rain gages, stone chimneys, ventilators, etc. This storm, coming as it did with high winds, which for the minute mentioned were in severe gusts, and with excessive rainfall, had the effect of cleansing thoroughly the spots where the hail struck, so that they could be counted on hard metal surfaces. It is reported that the hail drifted to a depth of two inches on the windward sides of three-story buildings near the Custom-House. This is probably true, as the count of the markings upon the instrument shelter, the tipping-bucket rain gage, and ventilators gave an average of 1000 marks to the square foot. At 2:25 a. m. there was vivid lightning and faint thunder from over the eastern horizon, the clouds overhead came from the west, and at that time a hissing, whistling sound could be heard which was strongest on the west side of buildings; this noise was also heard by other parties in different parts of the city. At 4:35 a. m. the sky had cleared. No very great damage resulted from this storm. The tin covering the west side of the shaft leading out on the roof of the Government building was dented over every inch of surface exposed. The anemometer cups were badly battered; 40 large dents were taken out of them. From all information that could be gathered, it is inferred that the track of this hailstorm was four miles in breadth, covering the entire city of Pensacola and its suburbs; it was traced to a point more than seven miles west of the station and beyond Bayou Texar, which is three miles to the east.

[1] This article is taken from the monthly meteorological report [Form 1014 A] of the Pensacola station for March, 1906, giving an account of a severe local thunderstorm which occurred on the night of the 2–3d.

A PECULIAR TEMPERATURE FLUCTUATION.

By Prof. WINSLOW UPTON, director of the Ladd Observatory. Dated Providence, R. I., April 2, 1906.

A peculiar thermometric change attended the passage of the barometric depression of March 3 over southern New England. The center of this depression, according to the observations of the Weather Bureau stations at 8 p. m. of the 3d and 8 a. m. of the 4th, went nearly over Providence, R. I., early on the 4th. The lowest barometric reading was recorded at 5 a. m. on the registering barometer (Richard Frères pattern) of the Ladd Observatory. The thermograph curve at this station shows that the temperature rose rapidly as the center approached, from 35° to 50° between 8 and 10:30 p. m., and to 52° by 3:20 a. m. Then it fell from 52° to 35° in an hour and a half, reaching its minimum just as the center of the depression passed. A rise to 48° by 11 a. m. followed, coincident with the slow rise of pressure. This was followed by the usual fall of temperature as the pressure rose and anticyclonic conditions came on.

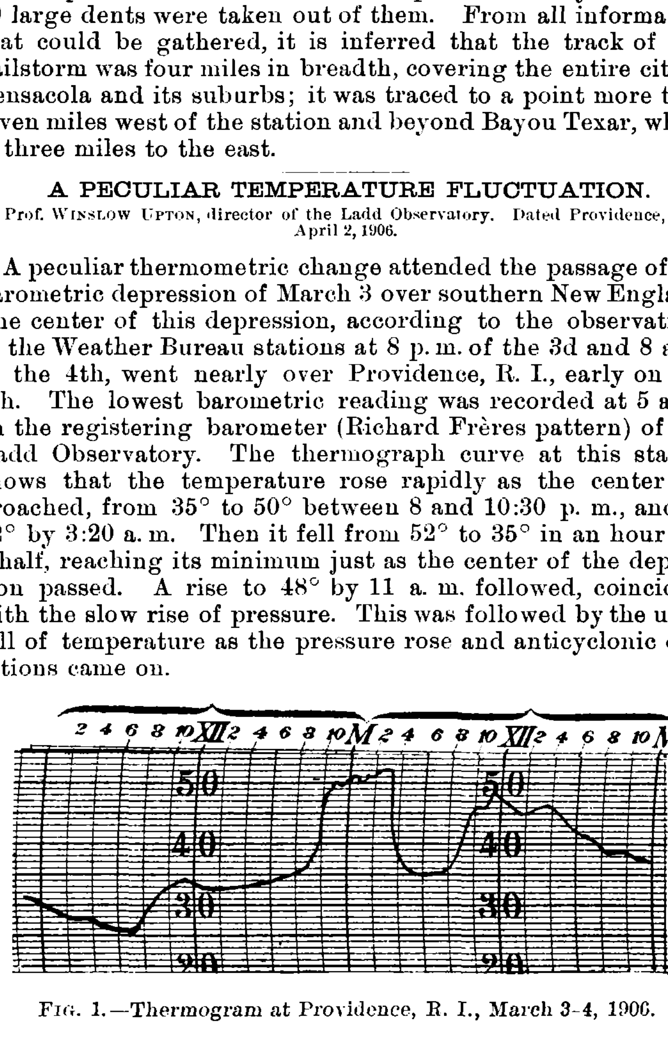

FIG. 1.—Thermogram at Providence, R. I., March 3-4, 1906.